3D MODELLING OF THERMIONIC CATHODES OF HIGH-PRESSURE ARCS*

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Current transfer to cathodes of high-pressure arc discharges may occur in a diffuse mode, when the current is distributed along the front surface of the cathode in a more or less uniform way, and in spot modes, when nearly all the current is concentrated is one or several regions (cathode spots) which occupy only a small fraction of the cathodes surface. If the cathode is axially symmetric, the diffuse mode is described by an axially symmetric solution, while spot modes are described by axially symmetric or 3D solutions. At present, steady-state axially symmetric solutions describing both diffuse and spot modes have been understood relatively well[1-3]. Results on 3D spot modes started to appear only recently[4-6]. In particular, it was shown[4] that 3D steady-state spot modes branch off from axially symmetric modes and bifurcation points have been found in which branching occurs. Results of calculations of several 3D steady states are given in Ref. 6.

In this work, a numerical investigation of steady-state 3D modes on a cylindrical cathode in atmospheric-pressure argon plasma is reported. The treatment is based on the model of nonlinear surface heating, which was used also in the above-cited works[1-6]. Results are given on the first two 3D modes, which are a mode with a spot on the edge of the front surface of the cathode and a mode with two spots on the edge opposite each other. Each mode is calculated and its properties studied in the whole domain of its existence, starting from the bifurcation point in which it branches off from the diffuse mode. A general pattern of current-voltage characteristics of various modes suggested previously on the basis of bifurcation analysis and general considerations is confirmed.

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